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The Association Between Patient-reported Clinical Factors and 30-day Acute Care Utilization in Chronic Heart Failure

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The Association Between Patient-reported Clinical Factors and 30-day Acute Care Utilization in Chronic Heart Failure

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Background: Heart failure patients have high rates of repeat acute care use. Current efforts for risk prediction often ignore postdischarge data.

Objective: To identify postdischarge patient-reported clinical factors associated with repeat acute care use.

Research Design: In a prospective cohort study that followed patients with chronic heart failure for 30 days postdischarge, for 7 days after discharge (or fewer days if patients used acute care within 7 days postdischarge), patients reported health status, heart failure symptoms, medication management, knowledge of follow-up plans, and other issues using a daily interactive automatic phone call.

Subjects: A total of 156 patients who had responded to phone surveys.

Measures: The outcome variable was dichotomous 30-day acute care use (rehospitalization or emergency department visit). We examined the association between each patient-reported issue and the outcome, using multivariable logistic regression to adjust for confounders.

Results: Patients were 63 years old (SD = 12.4), with 51% African-American and 53% women. Within 30 days postdischarge, 30 (19%) patients used acute care. After adjustment, poor health status [odds ratio (OR) = 3.53; 95% confidence interval (CI), 1.06–11.76], pain (OR = 2.44; 95% CI, 1.02–5.84), and poor appetite (OR = 3.05; 95% CI, 1.13–8.23) were positively associated with 30-day acute care utilization. Among 58 reports of pain in follow-up nursing notes, 39 (67%) were noncardiac, 2 (3%) were cardiac, and 17 (29%) were indeterminate.

Conclusions: Patient-reported poor health status, pain, and poor appetite were positively associated with 30-day acute care utilization. These novel postdischarge markers require further study before incorporation into risk prediction to drive quality improvement efforts.

Key Words: consumer health informatics, cardiovascular disease, care transitions, health services research, patient safety

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Transitions from inpatient care to home are challenging. Postdischarge patients are often subject to an early return (within 30 d) to acute care settings including rehospitalization[1,2] and emergency department (ED) visit.[3,4] Reducing repeat acute care utilization is currently a national priority, including efforts to reduce readmissions exemplified by the Hospital Readmissions Reduction Program.[5]

Current efforts to identify patients at risk of repeat acute care use incorporate information from administrative claims or electronic health records during the hospital stay, including demographics, comorbidities, laboratory test results, and prior service utilization.[6–9] These risk prediction tools (eg, the Readmission Risk score[10]) have moderate performance (0.55–0.73 *c*-statistics).[8,9,11] However, many events occur outside clinical setting, especially in the days following discharge, a vulnerable period for patients.[12–14] Postdischarge patient-generated data provide unique information about this uncertain period but are not routinely available in electronic health records. The value of monitoring patient-generated data for predicting repeat acute care utilization has had limited exploration in the literature.

Heart failure is an achetypal condition causing repeat acute care use. Heart failure patients have higher rates in readmission and ED revisit than other patients.[1,3] In the United States, the 30-day hospital readmission for heart failure patients is over 23% among older adults (older than

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65 y).[2,15] Using patient-reported data within 7 days postdischarge and before reusing acute care, we examined factors that predict 30-day acute care utilization among patients with chronic heart failure. We hypothesized that patient-reported clinical factors relevant to care transition,[16] including medication self-management, proper follow-up with health care providers, and knowledge regarding warning signs (shortness of breath, lower extremity swelling), would be associated with 30-day acute care utilization. We also explored additional patient-reported general clinical factors (eg, pain and appetite symptoms).

METHODS

Study Design

This evaluation follows a prospective cohort design, using postdischarge patient-reported data collected within the context of a larger care transition quality improvement study, whose primary results were published elsewhere.[17] Briefly, after discharge to home, patients with chronic heart failure completed daily assessments through interactive voice response (IVR) messages delivered to their home telephone for first 7 days daily and then either daily or every 3 days based on patient preference (total 28 calls). The IVR monitoring system was developed using the Care Transition Model.[17,18] When patients reported problems (eg, shortness of breath) in response to assessment questions (see examples in Supplemental Digital Content 1, http://links.lww.com/MLR/B913), the IVR system was programed to respond with self-management support messages. Further, patient-reported data from the IVR system was available to the care transition nurses through an online dashboard. Nurses were trained to identify patients with concerns and follow-up with them by telephone. Although high rates of engagement were observed with the IVR system and nurses followed up with patients who reported problems, the intervention did not result in lower rates of rehospitalization than a usual care control group.[17] In the additional analysis reported here, we included all patients who responded to at least 1 IVR-based survey both within the first 7 days after their index hospital discharge and before using acute care.

Setting and Sample

Patients were recruited from a Southern, tertiary care hospital between February 2010 and November 2011. This hospital serves as a safety net for low-resourced rural and urban populations in Alabama and neighboring states. The cohort included patients who were English speakers, were admitted with chronic heart failure, had an estimated prognosis of >6 months, had a telephone, and were expected to be discharged to their home. Exclusions consisted of being considered for heart transplant or placement of a ventricular assist device, or receiving ongoing dialysis, because a comprehensive postdischarge follow-up program had been integrated into their specialty care.

Full ethical approval was received from the Institutional Review Board. All subjects (or their proxies) provided written informed consent for study participation.

Data Collection

Patients completed a baseline survey in the hospital, which collected data on patient's demographics, socioeconomic status, and other background information. Prior ED use history (Have you been to the emergency room in the last 3 months?) and prior hospitalization (In the last 3 months, have you been hospitalized overnight?) were used to assess patients' recent health service utilization. The total score of the Cumulative Illness Rating Scale for Geriatrics (CIRS-G),[19] which is a validated adaptation of the original CIRS[20] for geriatric patients, was used to assess patients' burden of comorbid medical illness.

After discharge, patients received daily IVR-based surveys. The survey was developed by research staff working with clinical experts. It collected patient data in 5 care transition domains: health status, heart failure symptoms, medication management, follow-up plans, and other issues (Supplemental Digital Content 1, http://links.lww.com/MLR/B913). Because the parent study was designed as a real-world implementation trial, patients were not reimbursed for completing the surveys, allowing for heterogeneity in levels of participation.

Thirty day rehospitalization and ED visit were assessed by patient/caregiver self-report via telephone interview by trained data collectors blinded to study arm of the parent study. Rehospitalization data were verified for patients rehospitalized to the academic health center hosting the parent study through chart abstraction.

Patient-reported Clinical Factors

We analyzed 8 primary factors from 5 care transition domains. Each factor serves as a primary predictor variable[21] in our logistic regression analysis. The first factor, SF-1, is a single item assessment of generic health status. It is the first question of the validated Medical Outcomes Study Short-form 36 (SF-36) instrument, "In general, how would you rate your health?," with response options of "excellent, very good, good, fair, or poor."[22] We grouped responses with excellent, very good, or good into a single category good+ in our analysis. Other factors included symptoms typical for heart failure (shortness of breath and swelling[23,24]), medication adherence, follow-up appointment, and other issues like pain and appetite (see Supplemental Digital Content 1, http://links.lww.com/MLR/B913, for description of these factors and survey questions). We included pain, dizziness, and appetite in the survey because the patient population in our study were older and these symptoms are commonly reported in the geriatric population.

We calculated patient-level values using the following rules. For binary variables, the value was set to 1 if the patient indicated the issue in at least 1 survey within 7 days postdischarge and before using acute care. For example, if a patient reported pain in at least 1 survey response, the pain variable was set to 1 for this patient; otherwise, it was 0. For the ternary variable health status, the value was 2 if the patient reported poor health at least once, 1 if the patient reported fair health at least once and did not report poor health, and 0 if the patient reported good+ health in all the survey responses. We used patient-reported data within the first 7 days

postdischarge for 2 reasons. First, follow-up with heart failure patients within 7 days after discharge was associated with lower 30-day readmission,[13,14] suggesting the value of patient data collected during this period. Second, the way we collected the survey data was uniform for all the patients during this period (see the Study design section). Note that, for patients using acute care within 7 days postdischarge, we used only their data collected before reusing acute care.

In addition to the primary variables, we analyzed 10 secondary variables, most of which correspond to subsequent questions that were asked only when the patient's response to the primary question was positive. These additional questions used branching logic and assessed whether the patient-reported concern was a change from prior assessments and the severity of symptoms. For example, if a patient reported pain, 2 subsequent questions were asked respectively—if the pain was severe and if it was a new symptom.

Outcome Variable

Our primary outcome variable was a dichotomous variable indicating the 30-day acute care utilization, that is, whether or not a patient was admitted to hospital or used ED services at any point within 30 days postdischarge. Our secondary outcome variables included 30-day rehospitalization and 30-day ED visit (see Supplemental Digital Content 2, http://links.lww.com/MLR/B914).

Data Analysis

Statistical Analysis

We first assessed the overall rate of patient-reported issues. We then compared baseline patient characteristics across levels of patient-reported issues using χ^2 test or Cuzick Test for Trend[25] as appropriate. We defined 3 levels of patient-reported issues: (1) 0 issue; (2) 1 domain with issues; and (3) >1 domains with issues.

We assessed the outcome incidence rate associated with each primary or secondary factor. We then created separate multivariable logistic regression models to assess the association between each primary factor and the outcome variable by accounting for potential confounding by patient characteristics. We identified potential confounders from statistical analysis (Table 1; $P < 0.05$) and demographic factors frequently reported in the literature to be associated with the outcome. Because the parent study of this evaluation was a pragmatic trial that allows heterogeneity of patient response rates and flexibility in patient follow-up, we adjusted for this factor by including question-level nonresponse counts (ie, the number of days the patient did not respond to a specific survey question) and the number of follow-up phone calls to the patient as covariates.

Further, we conducted 2 secondary analyses for factors that we found to be associated with the outcome: (1) sensitivity analysis by adjusting for additional covariates assessed during index hospitalization, including severity levels of heart disease and gastrointestinal disease, and bodily pain (Supplemental Digital Content 3, http://links.lww.com/MLR/B915); and (2) for each factor we found, comparing its relative influence and that of each traditional factor considered by transition care (Supplemental Digital Content 4, http://links.lww.com/MLR/B916).

TABLE 1. Patient Characteristics by Levels of Patient-reported Issues

	n (%) or Mean [SD]				
Variables	All Patients (N = 156)	No Issues (N = 22)	Issues for 1 Category (N = 45)	Issues for 2–5 Categories (N = 89)	P*
Age (y)					0.18
< 50	22 (14)	7 (32)	2 (4)	13 (15)	
50–64	66 (42)	8 (36)	22 (49)	36 (40)	
≥ 65	68 (44)	7 (32)	21 (47)	40 (45)	
Sex					0.77
Male	74 (47)	11 (50)	23 (51)	40 (45)	
Female	82 (53)	11 (50)	22 (49)	49 (55)	
Race					0.15
White	75 (48)	7 (32)	20 (44)	48 (54)	
Black/other†	81 (52)	15 (68)	25 (56)	41 (46)	
Marital status					0.33
Married	74 (47)	13 (59)	23 (51)	38 (43)	
Not married	82 (53)	9 (41)	22 (49)	51 (57)	
Education					0.40
< High school	28 (18)	4 (18)	9 (20)	15 (17)	
High school/ GED	58 (37)	9 (41)	16 (36)	33 (38)	
Some college	41 (27)	7 (32)	13 (29)	21 (24)	
≥ College graduate	28 (18)	2 (9)	7 (16)	19 (22)	
Financial Security					0.62
No	50 (32)	8 (36)	12 (27)	30 (34)	
Yes	105 (68)	14 (64)	33 (73)	58 (66)	
Health literacy					0.69
Extremely	94 (60)	13 (59)	29 (64)	52 (58)	
Quite a bit	27 (17)	4 (18)	7 (16)	16 (18)	
Somewhat or not	35 (22)	5 (23)	9 (20)	21 (24)	
Smoking status					0.75
Never	67 (43)	11 (50)	18 (40)	38 (43)	
Former	75 (48)	8 (36)	25 (56)	42 (47)	
Current	14 (9)	3 (14)	2 (4)	9 (10)	
Prior ED use history (3 mo)					0.55
Yes	66 (42)	8 (36)	17 (38)	41 (46)	
No	90 (58)	14 (64)	28 (62)	48 (54)	
Prior hospitalization history (3 mo)					0.86
Yes	65 (42)	8 (36)	19 (42)	38 (43)	
No	91 (58)	14 (64)	26 (58)	51 (57)	
Comorbid medical illness burden‡	15.4 [4.8]	14.1 [4.9]	15.0 [4.8]	15.8 [4.7]	0.08

We collected patient data in 5 care transition domains: health status, heart failure symptoms, medication management, follow-up plans, and other issues. We then defined three levels of patient-reported issues: (1) 0 issues; (2) 1 domain with issues; and (3) more than 1 domain with issues.

*We used Cuzick Test for Trend to assess the trend of levels of patient-reported issues across the education levels, health literacy levels, or smoking status and χ^2 test to assess the difference in levels of patient-reported issues over other categorical variables. We treat age and comorbid medical illness burden as continuous variables and used Cuzick Trend Test to assess their distribution across the levels of patient-reported issues. A P-value <0.05 is considered to be statistically significant.

†The Black/Other category included 80 African Americans, which accounts for 51% (80/156) of the total participants.

‡Comorbid medical illness burden was measured by CIRS-G.

CIRS-G indicates Cumulative Illness Rating Scale for Geriatrics; ED, emergency department; GED, General Educational Development.

Analysis of Patient-reported Pain

Because pain is common in patients with heart failure but has not been well understood,[26–28] we further analyzed

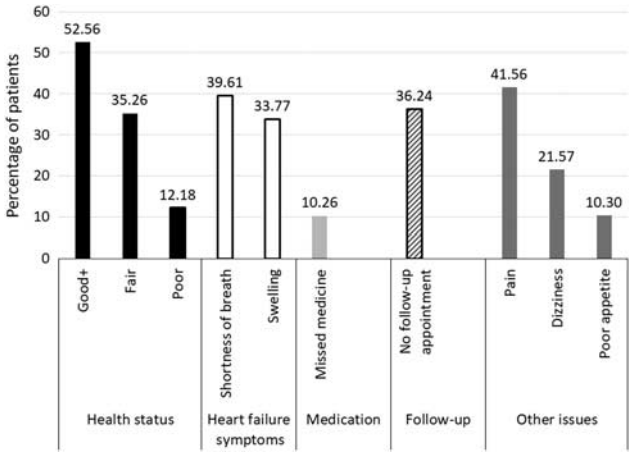

FIGURE 1. Prevalence of care transition issues in heart failure patients surveyed in this study.

the notes written by care transition nurses after they made follow-up phone calls with patients reporting pain, and categorized the locations of patient-reported pain. Because the parent study allowed flexibility in patient follow-up, nurses might not follow-up every issue reported by patients. We analyzed all the available nursing notes. One author (specialized in health informatics) reviewed the notes to identify and categorize notes recording pain. Another author (MD in General Internal Medicine) reviewed the notes and the assigned categories. The 2 annotators agreed on all the cases except for 1 case (example 5 in Supplemental Digital Content 5, http://links.lww.com/MLR/B917), which was discussed and then assigned the final label.

RESULTS

Patient Characteristics

Among the 168 patients who participated the IVR intervention group in the parent study, 156 (92.8%) responded to at least 1 survey within 7 days postdischarge and before using acute care and were included in this study. Mean age was 63 years (SD = 12.4); 51% were African American, 53% were women, and 18% had an education level lower than high school (Table 1), and patient characteristics were not significantly different across levels of patient-reported issues.

Patient Response to IVR Assessments

Patients responded to surveys on 98.7% of the days eligible to respond. A total of 147 (94.2% of 156) patients responded to all surveys. Question-level nonresponse rates are mostly <5%, except for dizziness (9%).

Most patients (86%, 136/156) reported at least 1 warning symptom or issue. Prevalence of reporting problems for each primary clinical factor ranged between 10% and 42% (Fig. 1).

Patient-reported Clinical Factors and 30-Day Acute Care Utilization

Within 30 days postdischarge, 30 patients used acute care (24 rehospitalizations, 18 using ED services; the overlap was 12).

TABLE 2. Distribution of 30-day Acute Care Use Over Primary Predictor Variables

Primary Variables	Outcome Incidence Rate, n/N (%)	P*
Overall	30/156 (19.2)	
Health status		*0.003*
Poor	8/19 (42.1)	
Fair	12/55 (21.8)	
Good, very good, excellent	10/82 (12.2)	
Heart failure symptoms		
Short of breath		0.52
Yes	13/61 (21.3)	
No	16/93 (17.2)	
Swelling		0.73
Yes	9/52 (17.3)	
No	20/102 (19.6)	
Medication management		
Missed medicine		1.00
Yes	3/16 (18.8)	
No	27/140 (19.3)	
Follow up		
Follow up appointment		0.42
Yes	16/95 (16.8)	
No	12/54 (22.2)	
Other issues		
Pain		*0.04*
Yes	17/64 (26.6)	
No	12/90 (13.3)	
Dizziness		0.63
Yes	7/33 (21.2)	
No	21/120 (17.5)	
Appetite		*0.01*
Poor	11/33 (33.3)	
Normal	16/115 (13.9)	

The predictor variables are calculated using survey results within 7 days postdischarge and before acute care use (rehospitalization or emergency department visit).

*We used the Cuzick test for Trend to assess the trend of 30-day acute care use across the levels of health status, Fisher exact test to assess the difference of 30-day acute care use over patients who missed taking medication versus patients who did not, and χ^2 test to assess the difference of 30-day acute care use over other categorical variables.

Statistically significant values of $P < 0.05$ are indicated in italics.

Among these patients, 27% (8/30) used acute care within the first week; 73% (22/30) and 40% (12/30) patients used acute care after the first week and the second week, respectively.

As shown in Table 2, patients reporting poor health status had a much higher outcome incidence rate than patients reporting good+ status (42.1% vs. 12.2%; trend test $P = 0.003$). The differences in outcome incidence rates between patients reporting pain and patients not reporting pain (26.6% vs. 13.3%; $P = 0.04$) and between patients reporting poor appetite and patients reporting normal appetite (33.3% vs. 13.9%; $P = 0.01$) were also high; while the differences were small for other factors. The incidence rates of 30-day rehospitalization and 30-day ED visit over the primary factors show similar patterns (Tables A2-1, A2-3, Supplemental Digital Content 2, http://links.lww.com/MLR/B914). Specifically, patients reporting poor appetite had a higher rate of 30-day rehospitalization (30.3% vs. 9.6%; $P = 0.003$) than patients reporting normal appetite. Patients reporting pain had a higher rate of 30-day ED use (18.8% vs. 5.6%; $P = 0.01$) than patients not reporting pain. Patients reporting shortness of breath also had a higher rate of 30-day ED use (17.7% vs. 6.5%; $P = 0.03$).

TABLE 3. Distribution of 30-day Acute Care Use Over Secondary Predictor Variables

Secondary Variables	Outcome Incidence Rate, n/N (%)	P*
Health status		
Change in health status		0.27
Worse	9/35 (25.7)	
Better or same	21/121 (17.4)	
Heart failure symptoms		
Short of breath (onset)		0.38
New	2/10 (20.0)	
Old	5/16 (31.3)	
No	16/93 (17.2)	
Short of breath (severity)		0.26
Minor activity	5/17 (29.4)	
Moderate or normal activity	4/20 (20.0)	
No	16/93 (17.2)	
Swelling (onset)		1.00
New	6/34 (17.6)	
Old	3/18 (16.7)	
No	20/102 (19.6)	
Swelling (severity)		0.69
Severe	1/7 (14.3)	
Mild or moderate	8/45 (17.8)	
No	20/102 (19.6)	
Medication management		
Feel certain about when to take medicines		0.35
Yes	23/110 (20.9)	
No	6/42 (14.3)	
Follow-up		
Need help to think about what to ask his/her doctor at next appointment		0.30
Yes	6/23 (26.1)	
No	18/107 (16.8)	
Other issues		
Pain (onset)		0.09
New	9/33 (27.3)	
Old	8/29 (27.6)	
No	12/90 (13.3)	
Pain (severity)		*0.006*
Severe	5/10 (50.0)	
Mild or moderate	12/53 (22.6)	
No	12/90 (13.3)	
Dizziness		0.06
New	6/16 (37.5)	
Old	1/17 (5.9)	
No	21/120 (17.5)	

The predictor variables are calculated using survey results within 7 days postdischarge and before acute care use (rehospitalization or emergency department visit).

*We used the Cuzick test for Trend to assess the trend of 30-day acute care use across the levels of severity of shortness of breath, swelling, and pain. We used the Fisher exact test to assess the difference of 30-day acute care use across the types (old, new, and no issues) of patient-reported shortness of breath, swelling, and dizziness. We used χ^2 test to assess the difference of 30-day acute care use over other categorical variables.

Statistically significant values of $P < 0.05$ are indicated in italics.

TABLE 4. Association of Primary Patient-reported Clinical Factors With 30-day Acute Care Use (Rehospitalization or Emergency Department Visit) Assessed by Logistic Regression, Unadjusted and Adjusted by Covariates

	Unadjusted		Adjusted by Comorbid Medical Illness Burden, Age, Race, Nonresponse Level*, Number of Follow-up Phone Calls	
Factors	OR (95% CI)	P	OR (95% CI)	P
Health status				
Excellent, very good, good	Reference		Reference	
Fair	2.01 (0.80–5.04)	0.14	1.58 (0.60–4.16)	0.36
Poor	5.24 (1.70–16.14)	*0.004*	3.53 (1.06–11.76)	*0.04*
Heart failure symptoms				
Short of breath				
No	Reference		Reference	
Yes	1.30 (0.58–2.95)	0.52	1.17 (0.49–2.76)	0.73
Swelling				
No	Reference		Reference	
Yes	0.86 (0.36–2.05)	0.73	0.94 (0.37–2.37)	0.89
Medication management				
Missed medicine				
No	Reference		Reference	
Yes	0.97 (0.26–3.63)	0.96	1.18 (0.29–4.90)	0.82
Follow-up				
Follow up appointment				
Yes	Reference		Reference	
No	1.41 (0.61–3.26)	0.42	1.27 (0.52–3.13)	0.60
Other issues				
Pain				
No	Reference		Reference	
Yes	2.35 (1.03–5.35)	*0.04*	2.44 (1.02–5.84)	*0.04*
Dizziness				
No	Reference		Reference	
Yes	1.27 (0.49–3.31)	0.63	0.96 (0.35–2.64)	0.93
Appetite				
Normal	Reference		Reference	
Poor	3.09 (1.26–7.58)	*0.01*	3.05 (1.13–8.23)	*0.03*

*Nonresponse: the number of surveys for which the patient did not respond to a specific question. Each survey question (primary variable) has a nonresponse variable. The covariate pattern nonresponse >0 for the question on health status predicts the outcome perfectly. The rest of the data was used to fit the logistic regression model for this question.

CI indicates confidence interval; OR, odds ratio.

Statistically significant values of $P < 0.05$ are indicated in italics.

As shown in Table 3, reporting severe pain was associated with higher risk of 30-day acute care utilization (50.5% vs. 13.3%; trend test $P = 0.006$).

After adjusting for age, race, comorbid medical illness burden, question-level nonresponse counts, and the number of follow-up phone calls, patients reporting poor health status were more likely to use acute care than patients reporting good+ status [odds ratio (OR) = 3.53; 95% confidence interval (CI), 1.06–11.76]; patients reporting pain (OR = 2.44; 95% CI, 1.02–5.84), or poor appetite (OR = 3.05; 95% CI, 1.13–8.23) were more likely to use acute care than patients not reporting such issues (Table 4). With regard to the separate outcomes (Tables A2-2, A2-4, Supplemental Digital Content 2, http://links.lww.com/MLR/B914), patients reporting poor appetite were more likely to be readmitted to hospital (OR = 3.77; 95% CI, 1.29–11.02); patients reporting pain (OR = 3.37; 95% CI, 1.15–9.89) or shortness of breath (OR = 3.03; 95% CI, 1.04–8.85) were more likely to use ED service within 30 days postdischarge than patients not reporting such issues.

Adjusting for additional covariates did not affect the main findings (Supplemental Digital Content 3, http://links.lww.com/MLR/B915). Pair-wise assessment of relative influence showed that poor health status, pain, and poor

appetite have stronger associations with the outcome than common factors considered by Transition Care Model (Supplemental Digital Content 4, http://links.lww.com/MLR/B916). After adjusting for shortness of breath or swelling, the association between poor health status and the outcome became nonsignificant. The other significant associations identified in the main analysis remained unaffected.

A total of 58 nursing notes recorded patient-reported pain, among which 2 (3%) were cardiac pain, 39 (67%) were noncardiac, and 17 (29%) were indeterminate. The most frequent categories for noncardiac pain include leg pain (10/39; 26%), abdominal pain (6/39; 15%), knee pain (5/39; 13%), back/hip pain (5/39; 13%), and headache (4/39; 10%).

DISCUSSION

Collecting data in the first week postdischarge may be valuable in preventing avoidable acute health care utilization.[13,14] We demonstrated that patients would respond to IVR assessments in the first week after discharge. Although our sample represents a complex, high-comorbidity patient population from a large geographic area, a high rate of responses was identified. In addition, 73% of early use of acute care occurred after the first week postdischarge and 40% occurred after the second week, suggesting an opportunity to intervene on patient-reported issues.

The most common concerns in care transition for heart failure patients, as suggested by the Care Transition Model,[16] are missing medications, no follow-up with health care providers, and typical symptoms for a worsening heart condition. Although we hypothesized that those concerns identified in the care transition model would have prognostic significance, we only found partial evidence to support this hypothesis from our data. For example, we observed a positive association between dyspnea (shortness of breath) and 30-day ED use (Table A2-4, Supplemental Digital Content 2, http://links.lww.com/MLR/B914). In contrast, we found 3 clinical factors, namely patient-reported poor health status, pain, and poor appetite, to be associated with the outcome (details below).

Patient's self-reported general health status (the SF-1 measure) has been shown predictive of mortality and hospital readmission.[29–32] Consistent with prior research, we found this measure associated with 30-day acute care utilization. This measure has not been frequently used for predicting repeat acute care use.[6–8] Future tools to identify high-risk patients may consider incorporating this measure.

Although dyspnea and edema (swelling) are typical symptoms of heart failure,[23,24] we did not find a significant association between these symptoms and 30-day acute care use. This may be attributed to several factors. First, these symptoms are well recognized in transition care, and their associations with the outcome could be reduced due to proactive interventions (eg, early follow-up and treatment). Second, these symptoms are prevalent in heart failure patients across levels of disease severity. The presence of these symptoms, therefore, may not be a strong marker of deteriorated conditions leading to repeat acute care use. Nevertheless, we did observe that dyspnea was associated with 30-day ED use (Table A2-4, Supplemental Digital Content 2, http://links.lww.com/MLR/B914). Future studies using larger samples may provide more insights on the association of these factors with readmission.

Although medication nonadherence and poor follow-up are common causes for readmission,[16,33] our study did not find them associated with the outcome. One possible reason is that we only used patient-reported adherence, which may not be sufficiently accurate.[34,35]

Interestingly, pain stands out as a strong indicator for 30-day acute care utilization in our study. Pain is common in patients in either early or advanced stages of heart failure, but has received less attention in transition care of those patients.[26–28] Prior studies focused on pain's impact on quality of life and loss of functionality.[26,27,36] To the best of our knowledge, our study is the first to identify pain to be associated with 30-day acute care use in heart failure patients.

Pain could be a marker of severity of heart failure, or unrelated to heart failure. Our analysis of the nursing notes indicated that many patient-reported pains were noncardiac and were frequently associated with legs, abdomen, knees, etc. The symptom of noncardiac pain in heart failure patients has not been well understood. The pain may originate by different mechanisms including ischemia, inflammation, and neuropathy, and also involve sociocultural, affective, cognitive, and behavioral components.[26,28] Multimorbidity is highly prevalent in heart failure patients and is under addressed.[37,38] Noncardiovascular diseases accounted for about 32%–45% readmissions of heart failure patients.[15,39,40] Patient's reports of pain may signal other comorbidities that drive patients back to the ED, and then readmission. In our data, the majority of patients who reported pain and were readmitted (71%; 12/17) were readmitted through ED. It is also plausible that patients came back to ED first due to pain, but the subsequent readmission was primarily related to the underlying heart failure symptoms (notably in the context that the ED physician may not have full context of the underlying heart failure severity and status at discharge). Further, pain may contribute to the breakdown of care transition process through various mechanisms, by increasing the workload of an already weakened heart, limiting physical activities or weakening self-management capability.[26–28]

Poor appetite was also associated with 30-day acute care use. Poor appetite is common in elder patients.[41] It has not been regarded as a typical symptom of heart failure,[42,43] although a recent study showed that 38% patients with mild or severe heart failure had decreased appetite.[44] Future research examining ways to improve appetite among postdischarge heart failure patients could significantly contribute to better transition care.

Successful transition care interventions have been mostly multicomponent, high-intensity programs.[16,45,46] These efforts may not be scalable to a large patient population. Identifying high-risk patients to prioritize the efforts may improve patient outcomes and cost-benefit ratios.[7,47,48] Our study contributed to this area by identifying novel markers from patient-reported data that can potentially be used for risk prediction. In particular, these markers capture unique information about the highly uncertain period of care transition that is missing in the in-patient data used by existing risk prediction tools.

Our findings are also relevant to the current state in the United States in that the penalty on higher-than-expected risk-adjusted readmission rates is for all-cause readmission. Signs for deteriorated overall health or functions reported by patients could be signals of deteriorated heart condition or other disease that need immediate attention. The findings from this study suggest that postdischarge follow-up assessment for heart failure patients may consider including assessments on SF-1, pain and poor appetite (in addition to typical heart failure symptoms). Note that the interplay between these nonspecific symptoms, heart failure severity and difficulties with care transition could be complicated. More studies using larger samples to further assess the interplay between these factors and the predictive value of these nonspecific markers are needed in the future.

All studies have limitations, and ours shares the limitation of all observational studies. Constrained by the parent study, conducted in 1 hospital, our findings do not directly generalize to other settings. As noted, the sample was limited. Constrained by the small data size, we only adjusted for a single comorbidity total score (rather than the individual scores) in our regression analysis. We also did not have complete data on reasons for readmission, only that the readmission occurred. Finally, we lacked further qualitative details on how patient-reported problems, such as pain or poor appetite, affected patients' transition care and led to early acute care use, although the literature has suggested various possible mechanisms.

We found that patient-reported poor health status, pain, and poor appetite were positively associated with 30-day acute care utilization in heart failure patients. As these measures were not identified a priori as hypothesized factors associated with the outcome (and recognizing the limitations of our sample), we consider this report important hypothesis-generating information. These novel postdischarge markers require further study before consideration for incorporation into risk prediction to drive quality improvement efforts.

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